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Short running head:

Ethnic inequalities in tooth loss

Title:

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Abstract

Objective: To assess whether there are ethnic differences in tooth loss among adult Americans under 40 years and whether socioeconomic position attenuates these differences if they exist.

Methods: Data were from the ***Behavioral*** Risk Factor Surveillance System 2014, a health-related telephone cross-sectional survey of a nationally representative sample of U.S adults. Tooth loss (one tooth or more) was used as the outcome variable. Ethnicity was the main explanatory variable. Family income, education and health insurance were also used in the analysis. Logistic regression models for tooth loss were constructed adjusting for demographic (age, gender, and ethnicity), socioeconomic indicators (income and education), health insurance, dental visits, smoking and diabetes.

Results: A total of 76,273 participants were included in the analysis**.** The prevalence of tooth loss was highest among Blacks (33.7%). Hispanics and other ethnic groups had a higher prevalence of tooth loss than Whites, 29.1% (95%CI: 27.7-30.6), 22.0% (95%CI: 20.3-23.8), and 20.8% (95%CI: 20.2-21.4), respectively. Black American had odds ratios (OR) 1.98 (95%CI: 1.81-2.16) for tooth loss compared to Whites. After adjusting for socioeconomic positions (SEP) the relationship attenuated but remained significant with OR 1.71 (95%CI: 1.55-1.90).

Conclusions: Despite recent changes in the healthcare system in the USA, ethnic inequalities in tooth loss still exist. Income and education partially explained ethnic differences in tooth loss among Americans under 40 years.

Key words: Tooth loss, Ethnicity, Oral Health, African Americans, Socioeconomic Factors.

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Introduction

There is an extensive evidence on ethnic inequalities in oral health in USA [1]. Repeated studies have shown that African and Hispanic Americans have higher rates of untreated caries, higher levels of periodontal diseases and more tooth loss than Whites [2, 3].

It was suggested that these ethnic inequalities are related to several factors specific to ethnic minorities. These include ***behavioral*** factors such as poor oral hygiene, smoking and poor diet [4]. Others have also argued that ethnic minorities are genetically more prone to diseases and to adopting unhealthy ***behaviors*** such as smoking or consumption of unhealthy diet [1, 5]. Lack of registration in the oral health care system was also implicated in poor oral health of ethnic minorities, particularly African Americans [6].

On the other hand, ethnic inequalities in general health in the US were attributed in different studies to other factors such as socioeconomic position (SEP) [7], area characteristics [8] and racial discrimination [9, 10]. In oral health, income and education were found to partially explain ethnic inequalities in USA [4, 11].

Given the contribution of lack of access to healthcare to the population health in general over the past few decades the in the USA, the Affordable Care Act (ACA) was established [12]. The ACA included a dependent coverage policy for Americans aged 19-25 years old that allowed access and benefits to dental care ***utilization***. Research showed an association between the ACA policy and increase in dental care ***utilization*** and private dental benefits, and decrease in the financial barriers on young Americans to access dental care [13]. Considering these observations, we postulate that ethnic variations in tooth loss and the role of socioeconomic factors have been lessened in recent years after the implementation of ACA. To test this hypothesis, we set out to examine ethnic variations in tooth loss among American adults under 40 years.

The objectives of this study are to assess ethnic differences in tooth loss among American Adults under 40 years, to examine whether family income and education level (SEP) attenuate ethnic differences in tooth loss, and finally to examine whether health insurance attenuates ethnic differences in tooth loss.

Methods

Data from the 2014 ***Behavioral*** Risk Factor Surveillance System (BRFSS), a nationally representative survey of US population were used. The BRFSS is a telephone interview survey that collects data from non-***institutionalized*** American adults aged 18 years and older. Information obtained for the BRFSS are mainly related to health, preventive services and chronic conditions associated with risk ***behaviors***. To maintain validity, representativeness and coverage of the BRFSS data, a new weighting methodology was used to increase the representativeness and reduce the potential for selection bias.

Outcome variable

The main outcome used in this study is tooth loss. Participants were asked 'How many of your permanent teeth have been removed because of tooth decay or gum disease? Include teeth lost to infection, but do not include teeth lost for other reasons, such as injury or orthodontics'. Answers for tooth loss were: (1) 1-5, (2) 6 or more but not all, (3) All, (4) None, (5) Don't know/ Not sure or (6) Refused. Given the younger age group included in this study (18-39 years), and lower probabilities of losing teeth at this age, tooth loss was modified into a dichotomous variable indicating missing at least one tooth versus no tooth loss. Those who refused or participants or not certain of the tooth loss were considered as missing values.

Main explanatory variable

Ethnicity was the main explanatory variable. The original variable of ethnicity included five groups: (1) White, (2) Blacks, (3) Hispanics, (4) Other race, and (5) Multiracial. For the purpose 'other race' and 'multiracial' were combined in one group 'Others'. Participants who refused to answer or were not sure of their ethnic group were ***categorized*** as missing values.

Covariates and confounders

Demographic characteristics such as age and sex were used in the analysis. The analysis was limited to those under 40 years. Age groups used in the analyses were (1) 18-24, (2) 25-29, (3) 30-34 and (4) 35-39.

Income and education were used as indications for SEP. Income was ***categorized*** to include 3 groups: low income: < $25,000; medium income: $25,000 to < $50,000; and high income: > $50,000. Education groups were: (1) less than 12 years of education, (2) high school/some college years, and (3) college or more.

Other covariates included smoking and diabetes for their known relationship with tooth loss. Smoking had 3 groups, namely current smoker, former smoker (who smoked more than 100 cigarettes), and never smoked. Diabetes indicated self-reported diagnosis of diabetes versus non-diabetic.

Dental visits and health insurance were used to indicate access and use of services. Dental visits indicated visits for routine check-ups within the past 12 months versus less often or never. Health insurance variable indicated if participants have any type of health care coverage, that include government plans such as Medicare, or health insurance, prepaid plans such as HMOs (Health Maintenance ***Organizations***), or Indian Health Services. The variable was ***categorized*** to indicate whether participants had any health care coverage or not.

Data analysis

Cluster, stratification and sample weights provided for both combined cellular phones and landline telephones were used to account for the complexity of the survey. Data weighting was part of statistical procedures to account for sampling bias. The analysis was limited to those with complete data in all included variables.

First, a descriptive analysis assessed the distribution of all included variables for the whole participants and by tooth loss (one or more tooth). Second, a set of logistic regression models were constructed to test the association between the outcome (tooth loss) and ethnicity. The first model was adjusted for demographic factors, namely age, gender, and ethnicity. The second model was further adjusted for smoking and diabetes. The third model was additionally adjusted for health insurance and dental visits. Lastly, the forth model was additionally adjusted for income and education.

Results

The analysis included 76,273 participants who answered all the questions. Table 1 shows the distribution of demographic and socioeconomic characteristics, related risk factors, and the percentage of tooth loss. The majority of participants were White (56.7%: 95%CI: 56.1-57.4), Blacks were 12.1% (95%CI: 11.7-12.6), Hispanics were 21.4% (95%CI: 20.8-22.0), and Others were 9.6% (95%CI: 9.1-10.0). Forty-nine percent of participants were females, of them 25.2% (95%CI: 24.5-26) had tooth loss. Males had lower prevalence of tooth loss 23.3% (95%CI: 22.6-24.1). Black Americans showed the highest percentage of tooth loss (33.7%: 95%CI: 31.5-35.0), while Whites had the lowest prevalence (20.8%: 95%CI: 20.2-21.4). A percentage of 33.4% (95%CI: 32.4-34.5) of tooth loss was reported in low-income group and it declined gradually at higher income levels. Similarly, tooth loss was notably higher among participant with the lowest level of education 44.1%. (95%CI: 42.0-46.2). Tooth loss was also higher among current smokers than never smokers, and among those who visited the dentist less often (Table 1).

Table 2 exhibits the results from the logistic regression models. Black Americans had odds of 1.98 (95%CI: 1.8-2.16) for tooth loss compared to White Americans after adjusting for demographic characteristics, while Hispanics and 'other ethnicities' had odds of 1.61 (95%CI: 1.48-1.74) and 1.13 (95%CI: 1.02-1.26), respectively. However, after adjusting for income and education, the odds ratios were attenuated to 1.71 (95%CI: 1.55-1.90) for Black Americans, 1.12 (95%CI: 1.02-1.24) for Hispanics, and 1.34 (95%CI: 1.20-1.50) for 'other ethnicities'.

Those who did not visit a dentist within the past 12 months had higher odds ratios for tooth loss (1.12: 95%CI: 1.05-1.20) compared to those who visited within 12 months. Participants who finished college or have higher education levels had OR of 0.30 (95%CI: 0.25-0.32) for tooth loss compared to those who have less than 12 years of education (Table 2).

Discussion

This study demonstrated that ethnic inequalities in tooth loss still exist in a nationally representative sample of USA adults under 40 years. Those who belong to African American ethnic group generally were more likely to lose their teeth than people from other ethnic groups. Similarly, Hispanic Americans had a higher prevalence of tooth loss than Whites. Interestingly, the significant association between ethnicity and tooth loss persisted even after adjusting for SEP. The prevalence of tooth loss was also higher among those with lower SEP, current smokers and diabetic individuals. Additionally, examining health insurance revealed that people who were covered by any health insurance had lower odds for tooth loss than those who were not covered.

The findings of the study supported the stated objectives to some extent. After adjusting for income and education, probabilities of missing at least one tooth attenuated but remained significant for the association between being Black Americans and tooth loss. These findings are also in line with evidence from a systematic review on socioeconomic determinants of tooth loss among adults [11, 14]. The findings are also consistent with another study on tooth loss which demonstrated highest prevalence of complete tooth loss among Blacks compared to Whites and Mexican Americans [15]. The current study however demonstrated this relation among younger age groups. Interestingly, despite the recent changes in the healthcare system, and the demographic changes, the findings on the role of SEP in ethnic differences in oral health were consistent with findings from earlier studies [4].

One of the aims of the introduction of the ACA in the USA was to extend dental health coverage and ***utilization*** and reduce ethnic and socioeconomic inequalities in insurance coverage [6]. Remarkably, after implementation of the ACA, there was evidence from low income Latino patients that Hispanics had the largest rate of insurance coverage, compared to all other ethnic

groups who had the same rates of insurance coverage [13]. However in the current study, although we did not assess dental coverage, but there was no evidence to suggest that ethnic inequalities in tooth loss or that the role of SEP in ethnic inequalities has changes compared to observations from earlier studies [12]. Having said this, it is worth noting that tooth loss is a cumulative condition and the condition could have pre-existed the ACA.

Furthermore, Barbato ***and*** Peres [16] have suggested that exposure to adverse environments such as poor socioeconomic conditions in early life can contribute to oral health problems specifically tooth loss throughout life time. Although we used a younger age group, it may appear that tooth loss could have happened earlier than ACA. ***However, since the implementation of the ACA, states that expanded Medicaid adults' dental benefits have shown an increase in use of dental care [17]. On the other hand, the future of access to dental care is extremely complex across states, services, and clients.***

Although the analysis was adjusted for dental visits and health insurance, but the types of services received during the dental visits were not included in the analysis and they could contribute to health outcomes and hence explain the persistent inequality in tooth loss. Earlier studies in the USA and UK have suggested that ethnic minorities and those at the bottom of the social hierarchy are less likely to receive preventive care and more likely to have decisive treatment such as tooth extraction when they visit a dentist [18,19]. It is also possible that ethnic minorities in the USA usually tend to seek definitive treatments as dental extractions to avoid financial burden of indirect cost such as cost of transportation, off work times, and multiple visits that could play a role as potential barriers for restorative or preventive dental services. These aforementioned factors could have all contributed to the ethnic disparities in tooth loss observed here.

Gender difference in tooth loss was also noticed in this study. It is known that women tend to seek general and oral services more often than men [20], however, frequent dental visits of women could contribute to more dental extractions. This may also explain why women had higher prevalence of tooth loss than men.

Most of literature on tooth loss examined participants from a wide range of age. The current study however focused on younger adults between 18-39 years old highlighting the significance that tooth loss is less likely to be experienced at early age, and to highlight that tooth loss is not due to natural process of aging.

There are few limitations of this study. Firstly, the nature of the cross-sectional survey does not allow conclusions on temporality. Secondly, there were no information specific to dental insurance. Self-reported data have the potential of recall or report bias. However, self-reporting in BRFSS were found to have moderate validity with slight differences over other national survey [21]. Moreover, validation of self-reported oral health conditions such as tooth loss is achieved by combining it with high agreement of clinical examinations that reflect clinical status [22].

Conclusions

The findings of this study were based on a very large representative sample of American adults from different states that could achieve much greater ***generalizability***. The analysis also accounted for several factors related to tooth loss to establish the independent relation between ethnicity and tooth loss. The study clearly demonstrated that in 2014 ethnic inequality in tooth loss still ***exists*** among a large sample of younger adults, and also demonstrated a role for socioeconomic condition in ethnic inequalities.

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Table 1:Variables distribution and percentages of tooth loss- BRFSS 2014 (N=76,273)

Variables		**Overall%** **(95%CI)**	**Tooth loss** **(95%CI)**	**P value**
Gender	Male	51% (50.3, 51.5)	23.3% (22.6, 24.1)	<0.001
	Female	49% (48.4, 49.6)	25.2% (24.5, 26)	
Age	18-24	30.1% (29.6, 30.8)	12.0% (11.2, 12.8)	<0.001
	25-29	22.8% (22.3, 23.3)	23.7% (22.6, 24.9)	
	30-34	25.0% (24.8, 26)	30.2% (29.1, 31.3)	
	35-39	21.5% (21.1, 22.0)	35% (33.7, 36.1)	
Ethnicity	White	56.7% (56.1, 57.4)	20.8% (20.2, 21.4)	<0.001
	Black	12.1% (11.7, 12.6)	33.7% (31.5, 35.0)	
	Hispanic	21.4% (20.8, 22.0)	29.1% (27.7, 30.6)	
	Others	9.6% (9.1, 10.0)	22.0% (20.3, 23.8)	
Income	< $25,000	33.4% (32.8, 34.0)	33.4% (32.4, 34.5)	<0.001
	$25,000- <50,000	25.3% (24.8, 26.0)	25.2% (24.2, 26.3)	
	$50,000+	41.1% (40.5, 41.7)	16.2% (15.5, 17.0)	
Education	<12	12.8% (12.3, 13.3)	44.1% (42.0, 46.2)	<0.001
	High school/some college years	60.8% (60.2, 61.4)	24.6% (24.0, 25.3)	
	College or more	26.4% (26.0, 26.8)	13.9% (13.2, 14.5)	
Smoking	Current smoker	20.5% (20.0, 21.0)	38.5% (37.2, 40.0)	<0.001
	Former smoker	14.5% (14.1, 15.0)	28.0% (26.5, 29.3)	
	Never smoked	65.0% (64.3, 65.5)	19.0% (18.3, 19.5)	
Diabetes	Absent	97.8% (97.6, 98.0)	24.0% (23.3, 24.4)	<0.001
	Present	2.1% (2.0, 2.3)	41.1% (37.1 45.1)	
Dental visits	Less often or never	37.3% (36.8, 38.1)	26.3% (25.4, 27.2)	<0.001
	Within the last 12 months	62.5% (62.0, 63.1)	23.0% (22.4, 23.7)	
Health Insurance	No	20.3% (19.7, 20.8)	34.2% (32.8, 35.0)	<0.001
	Yes	79.7% (79.1, 80.2)	21.7% (21.1, 22.3)	

Table 2: Logistic regression analysis presenting Odds Ratios and 95% CI for factors associated with tooth loss among adults in the United States, BRFSS 2014 (N= 76,273)

Variables		Model 1	Model 2	Model 3	Model 4
Gender	**(Ref group Male)**	1.06** (1.00-1.13)	1.17*** (1.10-1.25)	1.20*** (1.12-1.27)	1.12*** (1.05-1.20)
Age (Ref group 18-24)	**25-29**	2.29*** (2.07-2.53)	2.12*** (2.11-2.35)	2.12*** (2.11-2.34)	2.52*** (2.26-2.80)
	30-34	3.22*** (3.03-3.53)	3.23*** (2.65-3.21)	3.03*** (2.66-3.23)	3.66*** (3.31-4.05)
	35-39	4.00*** (3.65-4.40)	3.78*** (3.43-4.16)	3.86*** (3.51-4.25)	5.01*** (4.52-5.54)
Ethnicity (Ref group White)	**Black**	1.98*** (1.81-2.16)	2.20*** (1.29-2.40)	2.12*** (1.93-2.33)	1.71*** (1.55-1.90)
	Hispanic	1.61*** (1.48-1.74)	1.84*** (1.70-2.00)	1.65*** (1.51-1.80)	1.12* (1.02-1.24)
	Others	1.13*** (1.02-1.26)	1.27*** (1.13-1.42)	1.27*** (1.14-1.42)	1.34*** (1.20-1.50)
Smoking (Ref group Current smoker)	**Former smoker**		0.54*** (0.50-0.60)	0.56*** (0.51-0.61)	0.68*** (0.61-0.74)
	Never smoked		0.34*** (0.32-0.37)	0.35*** (0.33-0.38)	0.46*** (0.42-0.50)
Diabetes	**Non-diabetic**		1.65*** (1.37-2.04)	1.67*** (1.38-2.02)	1.39** (1.14-1.68)
Health insurance	**No health insurance**			0.60*** (0.55-0.65)	0.82*** (0.75-0.90)
Dental visits	**(Ref group Less often or never)**			1.12*** (1.05-1.20)	1.34*** (1.25-1.44)
Income (Ref group < $ 25,000)	**$25,000-<50,000**				0.74*** (0.68-0.80)
	> $ 50,000				0.50*** (0.45-0.53)
Education (Ref group <12 years of education)	**High school/some college years**				0.56*** (0.51-0.63)
	College or more				0.30*** (0.25-0.32)

Model 1: adjusting for gender, age and ethnicity.
Model 2: model 1 + smoking and diabetes.
Model 3: model 2 + health insurance and dental visits.
Model 4: model 3 + income and education.

$^{***}p<0.001$, $^{**}p<0.01$, $^{*}p<0.05$